User Manual

Modality Emulator

25/02/2009

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1 Introduction

1.1 Revision History

Version	Author	Date	Description
0.1	P.G. Brouwer	13-10-2008	First version of this document, describing the functionality of version 3.1.1.
0.2	P.G. Brouwer	28-10-2008	This document describes the functionality of version 3.1.1.

1.2 General

The Modality Emulator software has been tested on a regular computer with Windows XP Professional SP3 loaded. For compatibility with other operating systems see the DVTk website.

1.3 Summary

The Modality Emulator can be used to emulate all the DICOM functions of a modality system. You can use it:

- To test and verify communication with all the DICOM services a real modality would use.
- Or if you want to test the interaction of your own applications services with a modality.

The detailed reporting gives you full feedback and analyses of all the communication.
It can use DICOM files as input for Queries, MPPS and Storage actions, allowing you to utilize your own real medical data.

1.4 Key Features

- TCP/IP Ping and DICOM Verification
- Query Modality Worklist
- Modality Performed Procedure Step updates
- Storage
- Storage Commitment
- Detailed results with data highlighting
- Validation of attribute mapping

1.5 Audience

Service engineers can quickly replace real modalities in medical environments with the emulator and verify the connectivity of all the DICOM services involved. Test engineers and developers can use it to emulate a medical environment for testing software products with complete workflow scenarios.

1.6 System Requirements

- Microsoft Window XP
- .NET 2.0 Framework

1.7 Acronyms and Abbreviations

Term	Meaning
IHE	Integrating the Healthcare Enterprise. For more information see
HIS	Hospital Information System
IHE	Integrating the Healthcare Enterprise
IOD	Information Object Definitions
MPPS	Modality Performed Procedure Step
MWL	Modality Worklist
NEMA	National Electrical Manufacturers Association
PACS	Picture Archive and Communication System
PPS / MPPS	Performed Procedure Step / Modality Performed Procedure Step
RIS	Radiology Information System
RSNA	Radiological Society of North America
SCU	Service Class User
SCP	Service Class Provider
UID	Unique Identifier

1.8 Glossary

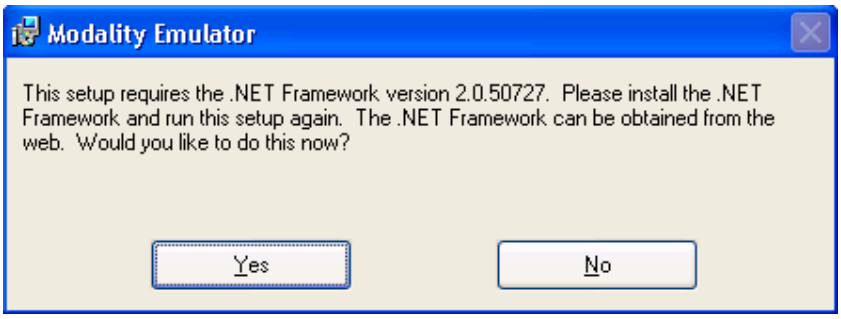
Term	Meaning
Actor (IHE)	Actors are information systems or components of information systems that produce, manage, or act on information associated with operational activities.
Broker	One of the tasks that a Broker does is converting HL7 messages into DICOM messages. In this document the term RIS will be used, when actually the broker is mend, for two reasons: ▪ Modality manuals generally refer to RIS instead of Broker, ▪ The screens of the Modality Emulator also refer to RIS. The MWL functionality is supplied by the Broker! See also: "1 **Error! Not a valid result for table.**"
HL7	Health Level 7. A compact language used in medical environment to transmit information.
IHE	Integrating the Healthcare Enterprise. For more information see www.ihe.net
RIS	Radiology Information System. RIS systems typically "speak" HL7. A new trend is "Brokerless", which means that Broker functionality is integrated into the RIS system.
Template	In this document the term template is used to indicate a (part of a) DICOM that can be used to simulate the Modality Emulator behaviour.

2 Software Installation

The software installation procedure of the Modality Emulator application consists of the following steps:

- Installation of the Microsoft .NET Framework R2.0.
- Installation of the Modality Emulator application.

The installer checks the presence of .NET Framework 2.0. If this package is not installed, the following message will appear:

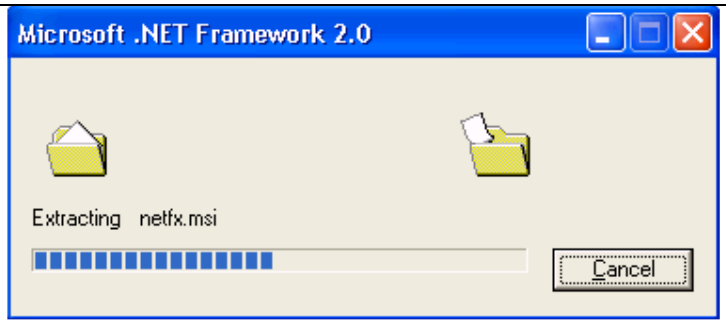

Modality Emulator
This setup requires the .NET Framework version 2.0.50727. Please install the .NET Framework and run this setup again. The .NET Framework can be obtained from the web. Would you like to do this now?
Yes
No

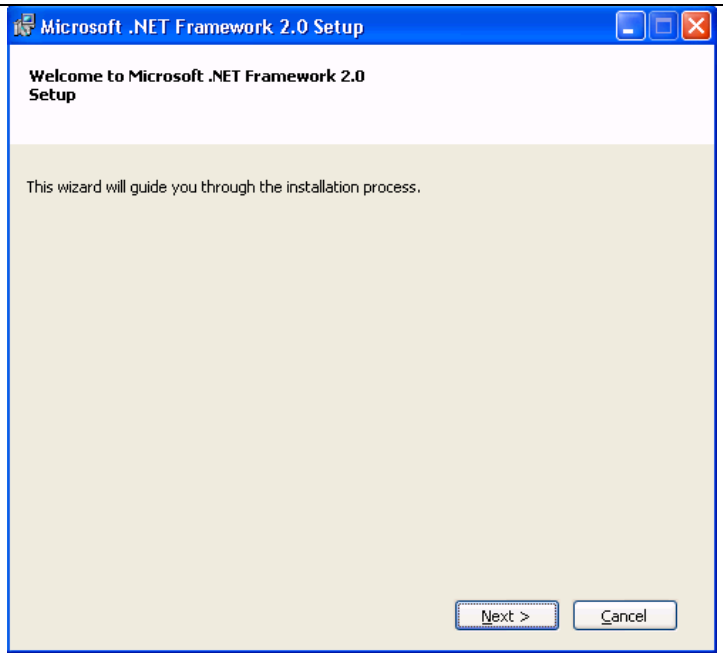
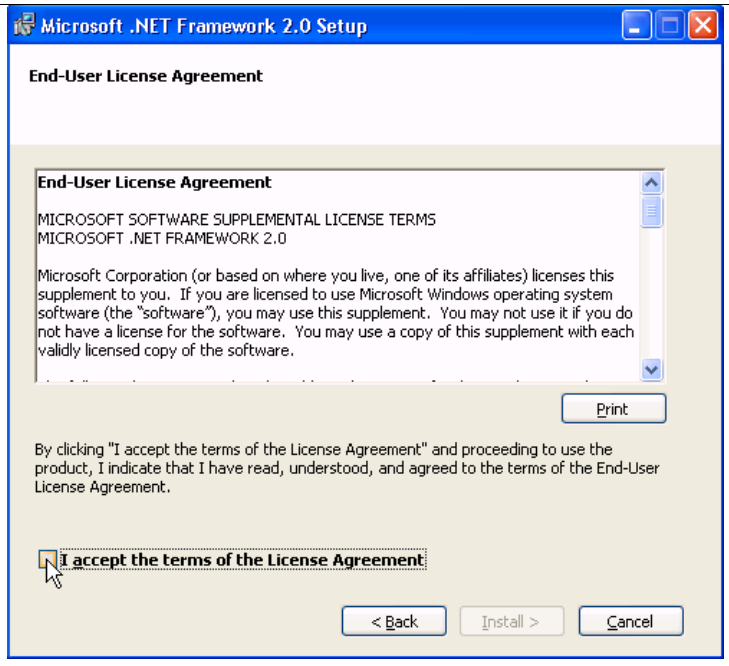
- Pressing Yes: The software will be downloaded from the Microsoft website and installed. (This step requires an internet connection.).
- Pressing No: The installation will be stopped.

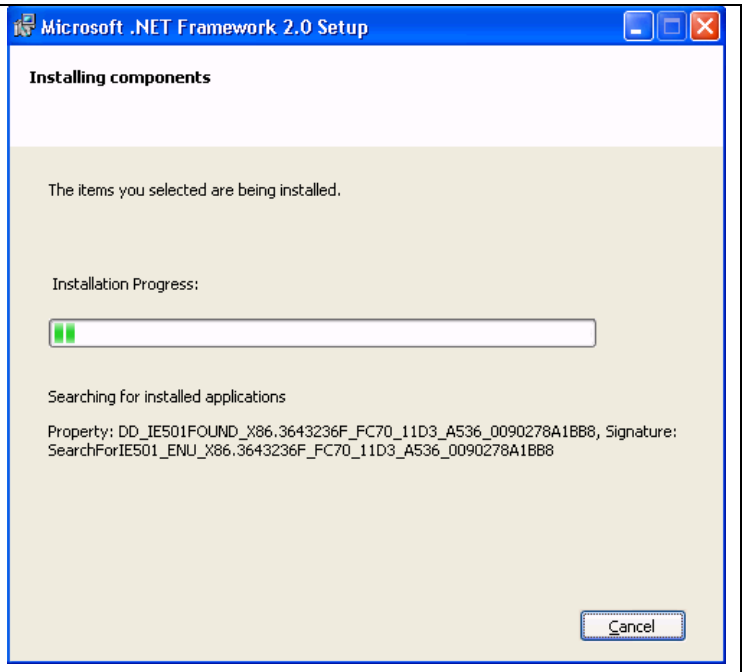
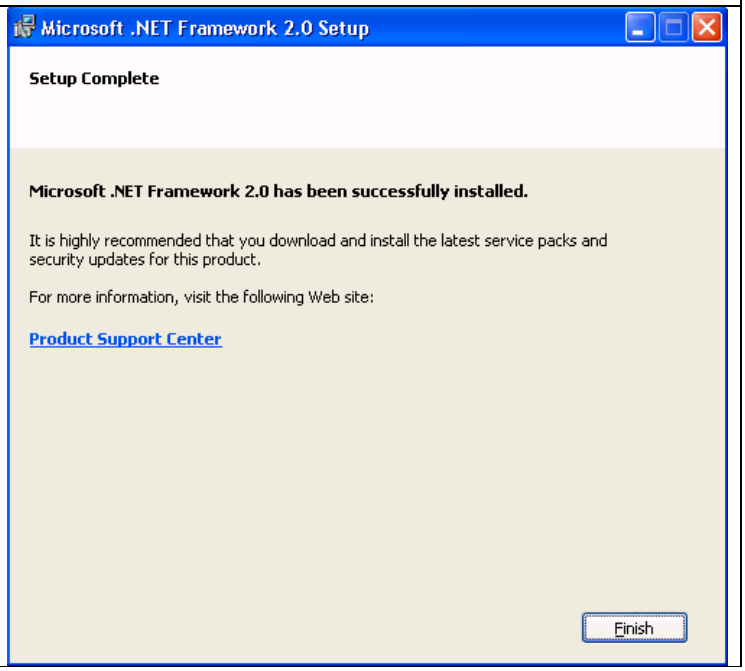
Important: Before starting with the Modality Emulator application installation, remove any previous installed version of the Modality Emulator application. Use windows "Add or Remove Programs" to remove the program.

2.1 .NET Framework installation (optional)

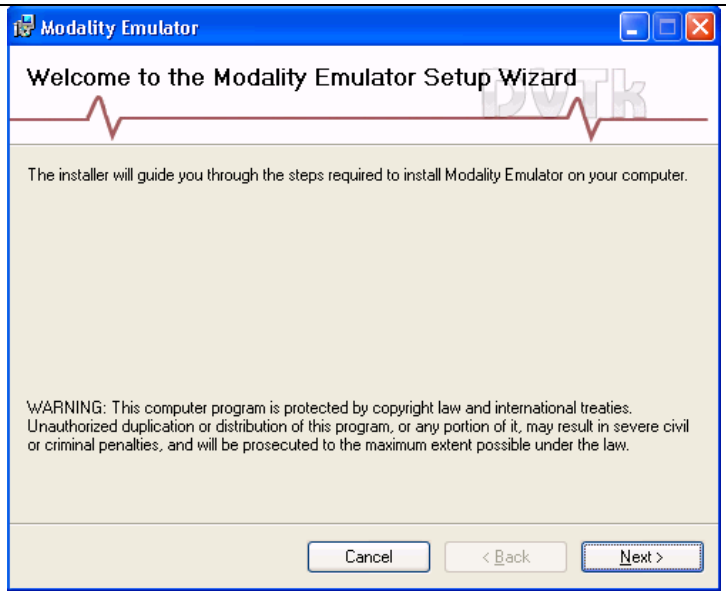
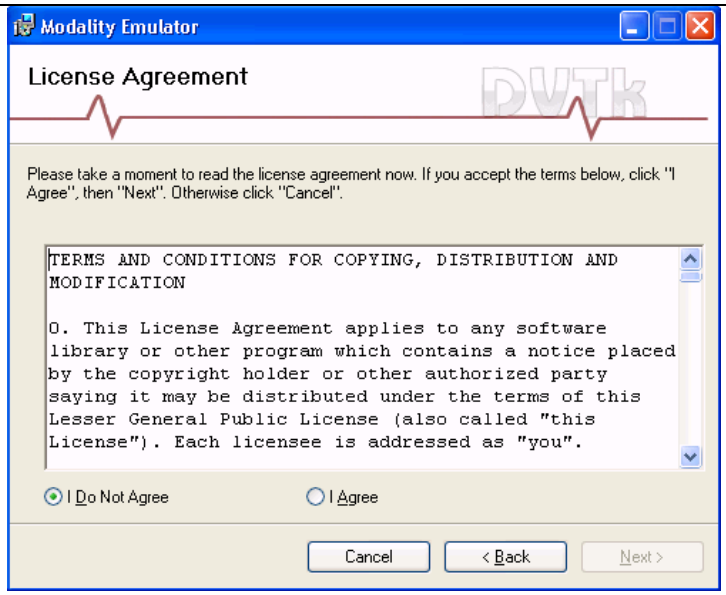
On the Microsoft website the executable for .NET Framework 2.0 can be downloaded. Use this method when no internet connection is available. The steps below guide you through the installation of .NET Framework 2.0.

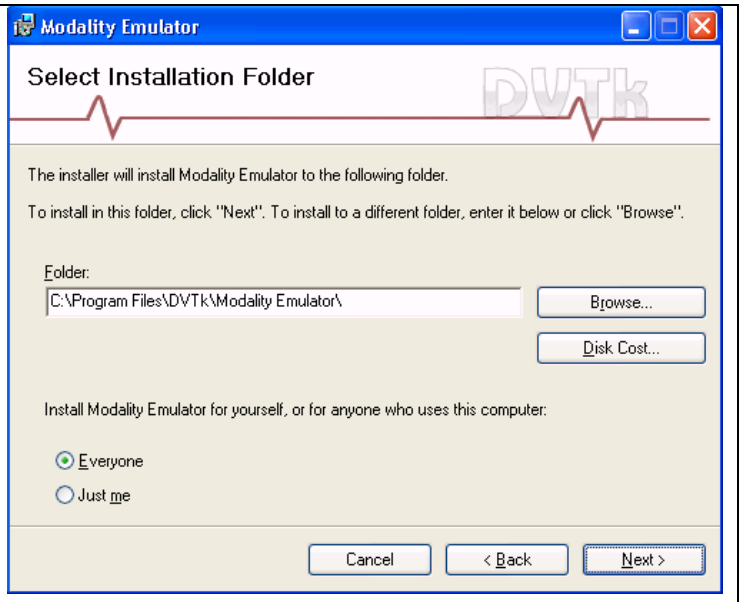
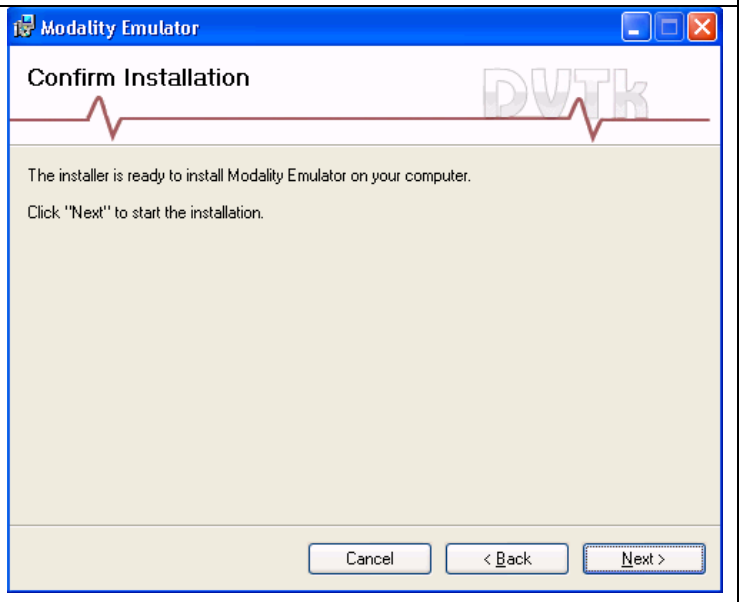
When the .NET Framework installation is started, the following screen appears.	

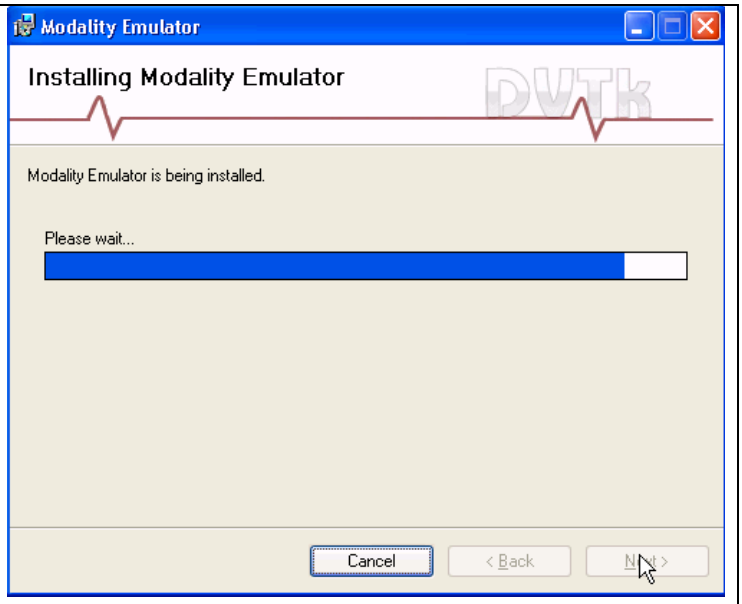
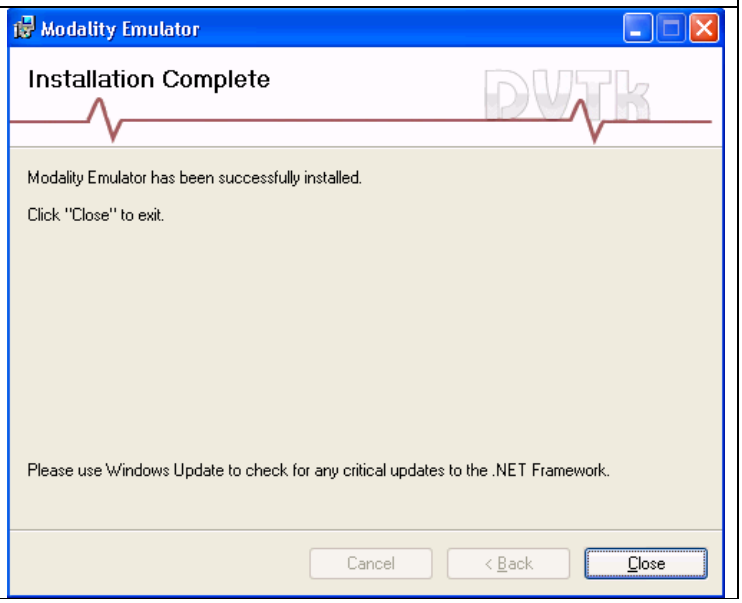
Press "Next"	
After reading the End-User License Agreement, tick the box "I accept the terms of the License Agreement". Press "Install".	

Time for coffee ….	
Click "Finish" to complete the .NET Framework installation.	

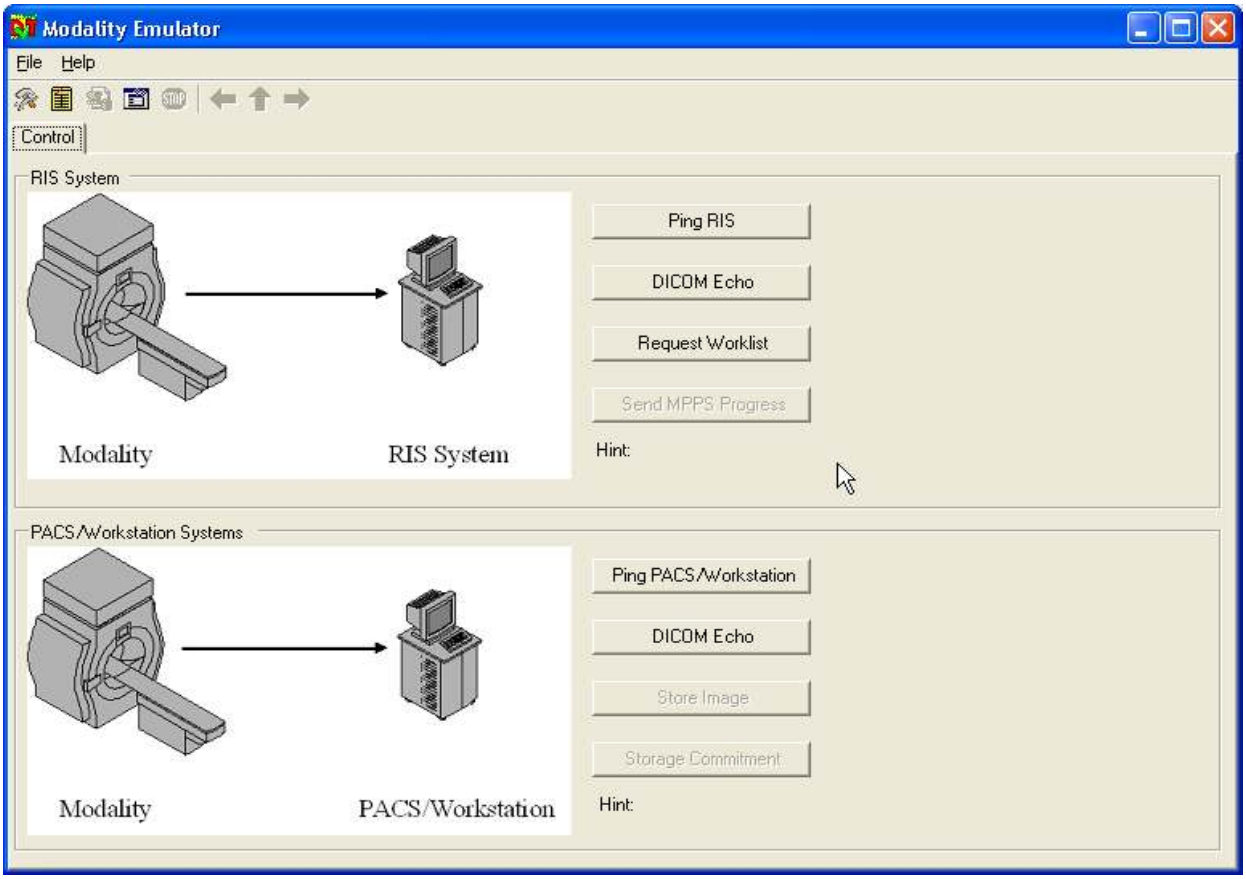
2.2 Modality Emulator installation

Click the Modality Emulator installation file to start the installation. Press "Next".	
After reading the License Agreement, tick the box "I agree". Press "Next".	

Keep the default destination for the place where the program will be installed. Keep the default “everyone”. Press “Next”	
Press “Next”	

Another coffee …	
Press "Close" to complete the installation.	

3 Modality Emulator – User Interface



3.1 File Menu

File Help Configure Systems Configure Emulator Exit	Press "File, Configure Systems" to add an extra tab in the application. Control | Configure Remote Systems | In this Configure Remote Systems menu the various parameters are set to connect to the remote systems.
	Press "File, Configure Emulator" to add several tabs in the application. Control | Configure Emulator | Worklist Query | MPPS-Progress | MPPS-Discontinued | MPPS-Completed | Image Storage | Dummy Patient In these tabs various parameters can be set.
	Press Exit to exit the application

3.2 Help menu

Help About Modality Emulator	Press "Help" to view the version number.	

3.3 Button bar

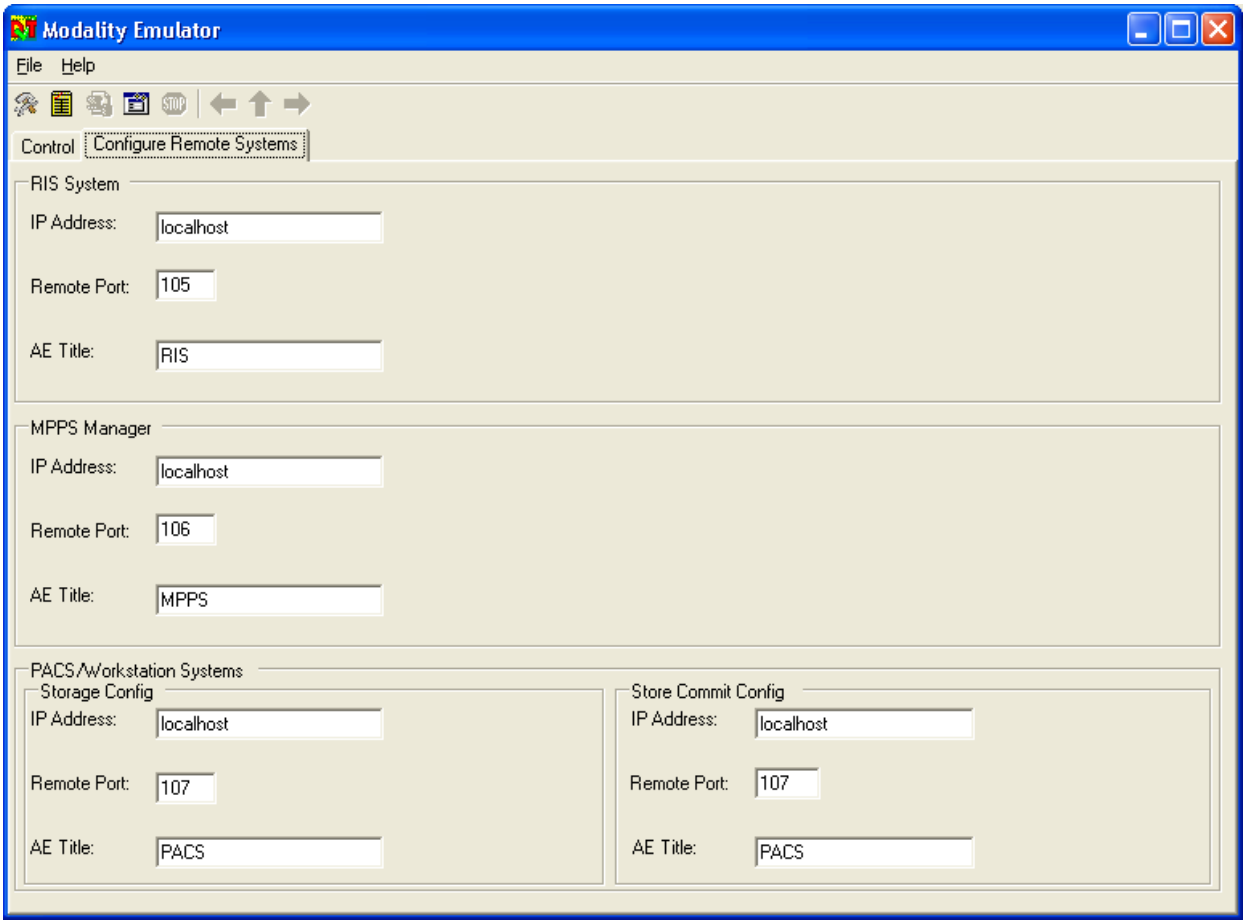
Just below the menu bar you can see the "button-bar".

Icon	Meaning
	Press this button to get the "Configure Emulator" tabs
	Press this button to get the "Configure Systems" tab
	Press this button to display the results
	Press this button to get the tab "activity logging".
	To stop the emulator
	Go Back (only applicable in "Results" window)
	Go Top (only applicable in "Results" window)
	Go Forward (only applicable in "Results" window)

4 Configuration

4.1 Configure Remote System

Use the Menubar or Buttonbar to open the Modality Emulator configuration. The screen as shown below will open:



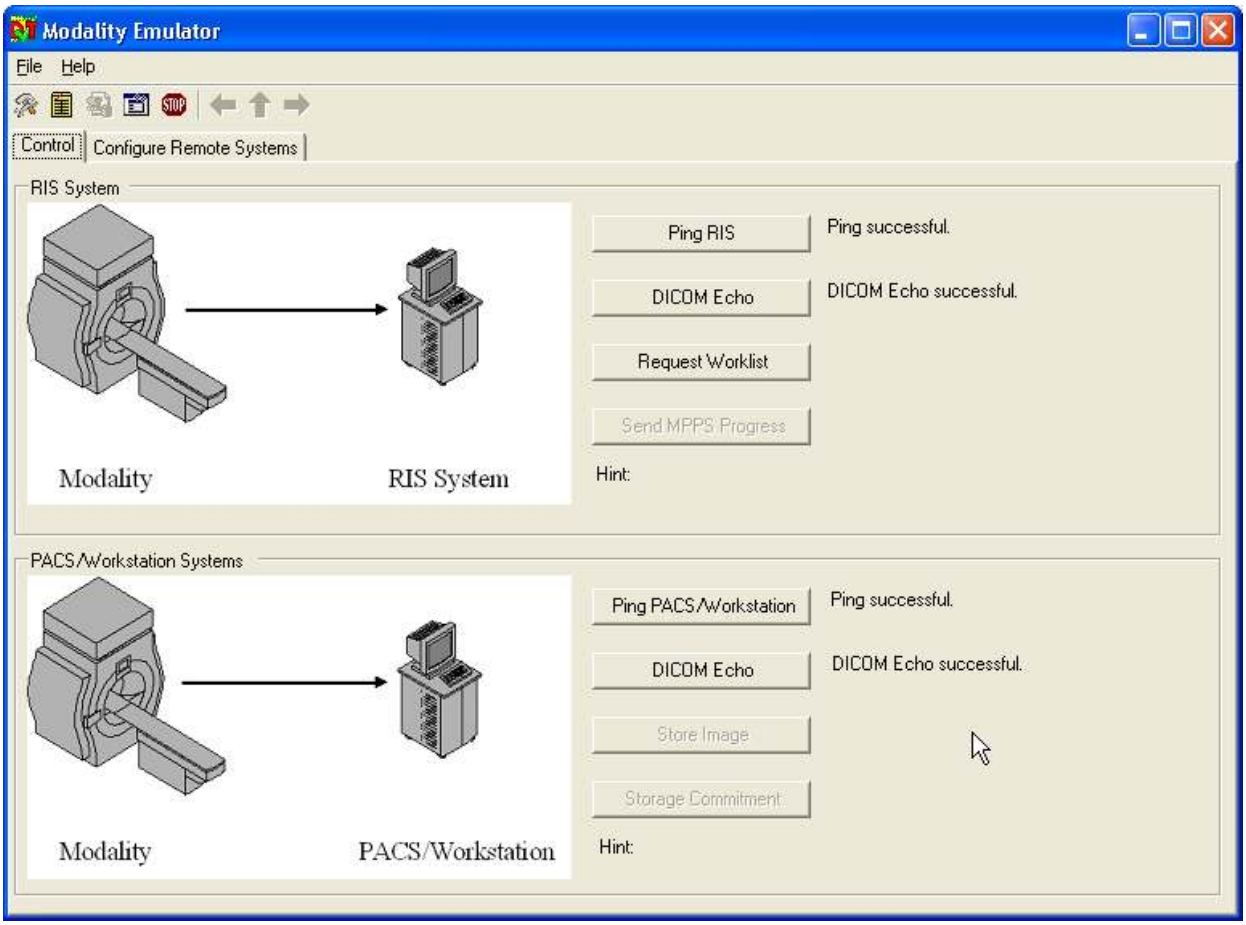
RIS System	Here you should read the Worklist provider. Mostly this is the broker that is connected to the RIS! Enter correct IP-Address, Port number and AETitle.
MPPS Manager	The MPPS manager handles the MPPS messages. In most cases this is the same broker as described above, but using different AET/port. Enter correct IP-Address, Port number and AETitle.
PACS/Workstation Systems	The location where the images will be stored. Enter correct IP-Address, Port number and AETitle.
Store Commit Config	When the store location above is the PACS, a Storage Commit can be requested. Enter correct IP-Address, Port number and AETitle.

When the IP-Addresses, Port-Numbers and AET's have been entered, the connections can be tested. Go to the tab "**Control**".
In the area RIS System:

- Press the button **Ping RIS**. When the text "Ping Successful" is displayed, the TCP/IP connection between Modality Emulator and RIS is OK.
- Press the button **DICOM Echo**. When the text "DICOM Echo Successful" is displayed, the DICOM association ("DICOM Ping") between Modality Emulator and RIS is OK.

In the area PACS/Workstation Systems:

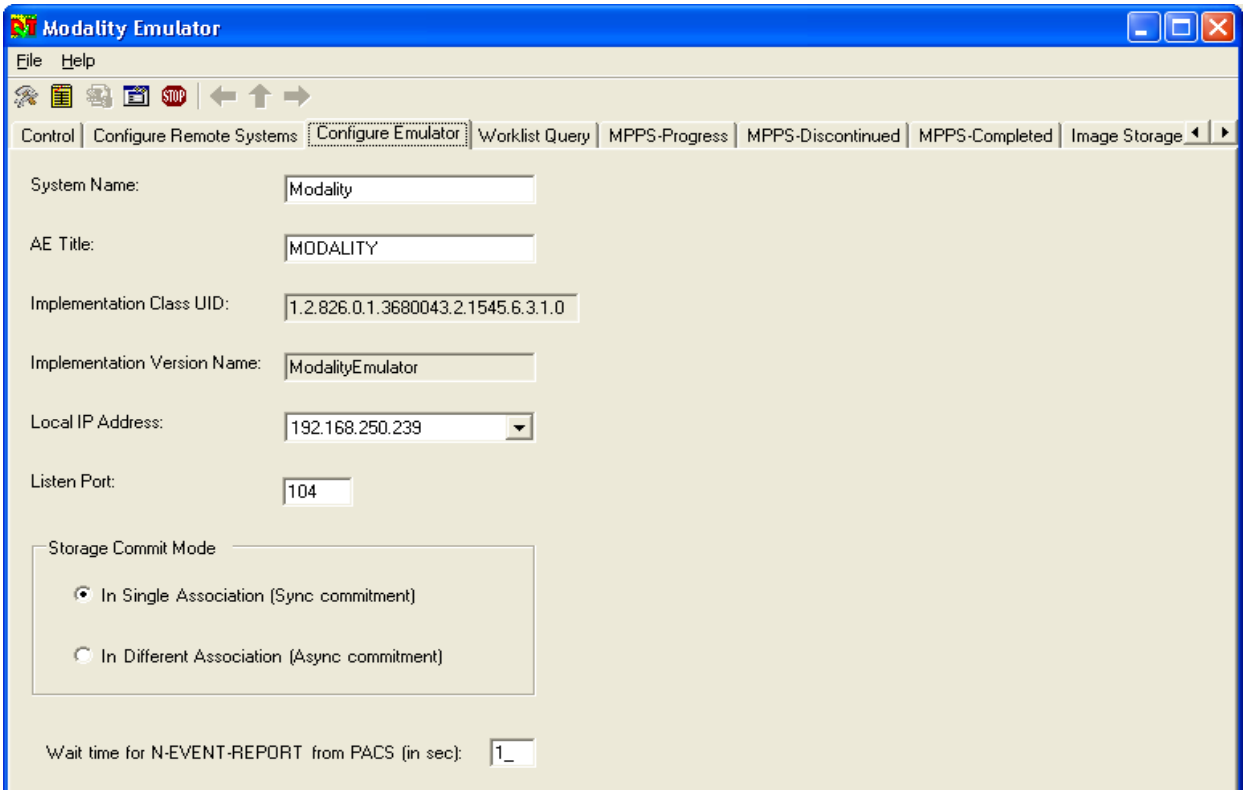
- Press the button **Ping PACS/Workstation**. When the text "Ping Successful" is displayed, the TCP/IP connection between Modality Emulator and PACS/Workstation is OK.
- Press the button **DICOM Echo**. When the text "DICOM Echo Successful" is displayed, the DICOM association ("DICOM Ping") between Modality Emulator and PACS/Workstation is OK.



Experience based tip:	When the settings have been made, and the "ping" and "DICOM echo" was successful, close the program, followed by restarting the program. Why? Then the settings are stored. If you would have to kill the program, non-stored settings are lost.

4.2 Configure Emulator

Use the Menubar or Buttonbar to open the Configure Emulator tab's. Select the tab "Configure Emulator". The screen as shown below will open:



System Name	Although this name is not so important, some remote systems use the combination System Name and Local IP-Address as authorization to allow access.
AE Title	The name that will be used in the association negotiation. Most systems require that this name is known/configured in the remote configuration.
Local IP Address	IP-Address of the computer that runs the Modality Emulator application. The default entry is taken from the network settings. Only when more network cards are used, make sure the correct address is selected.
Listen Port	The port on which the Modality Emulator application can receive a DICOM association.
Storage Commit mode.	**Single association:** The connection between the Emulator and the PACS remains open for the N-Event-Report, unless the wait time has elapsed. **Different association:** The connection between the Emulator and the PACS will close directly after the Commit request. The PACS will open a new association to sent the N-Event-Report.
Wait time for N-Event-Report.	When this time (in seconds has elapsed) the association will be closed. Only applicable for single association Storage Commit mode.

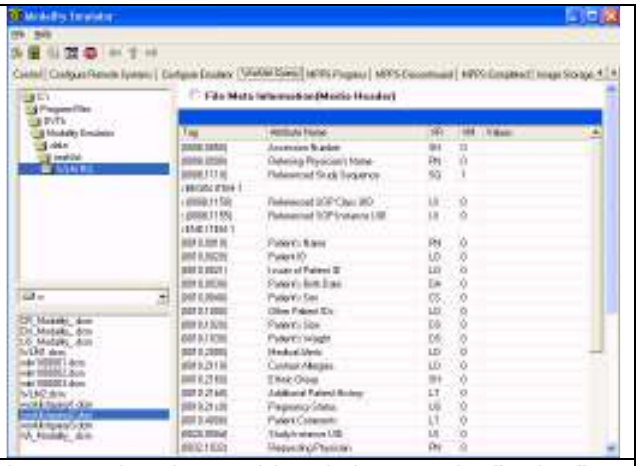
4.3 Templates for Emulator behaviour

The function of Modality Emulator Application is to emulate a modality, what a surprise! But the program is doing this in a very smart way! As can be seen in the screenshot below, several tab's exist for configuring the behaviour of the emulator. When the system has queried for a specific patient, the MPPS and Store templates will be modified to match patient demographics.
For details about mapping see paragraph: **7 Mapping information**.

4.3.1 Workflow Query template

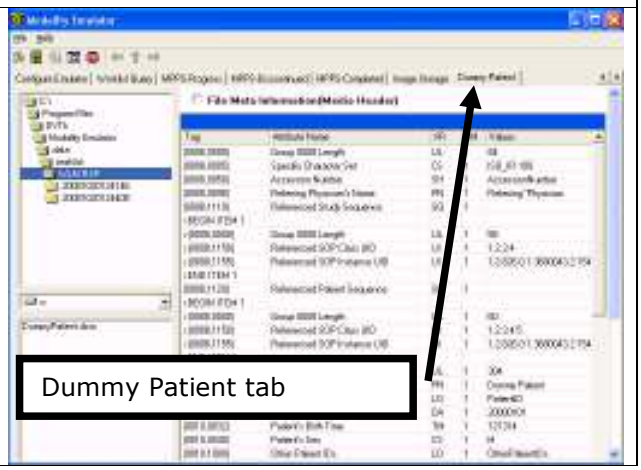
When the Worklist Query tab is pressed, the screen at the right is shown:

- The left-hand top side is showing the directory where template files are located. The screenshot shows the default location for the template files. The program will remember the directory where the template was last loaded.
- The left-hand bottom side is showing the selected template.
- The right pane of the screenshot shows the tags.



Load the template that matches your use. The values can be changed by clicking in the "value" column, enter the value that should match. Confirm by pressing the enter button.

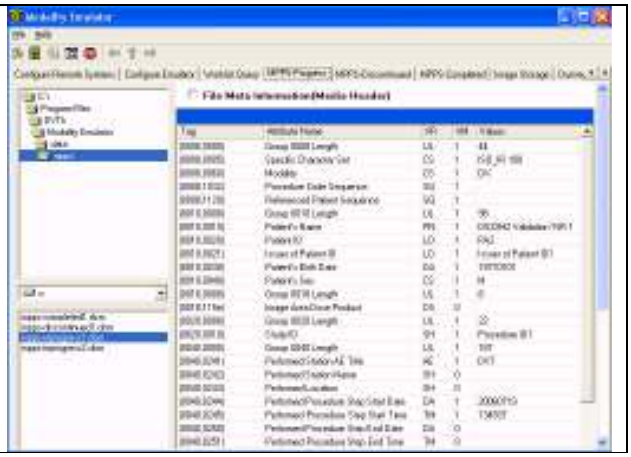
When no connection is made to a RIS, the "Dummy Patient" can be used. The values of the Dummy Patient can be configured in the Dummy Patient tab.



4.3.2 MPPS – Progress template

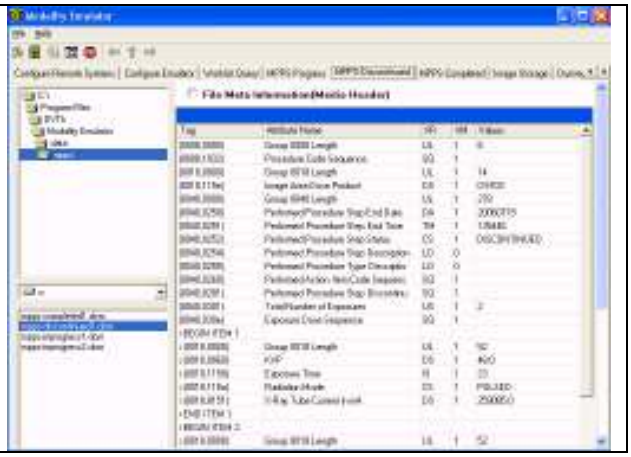
When the MPPS Progress tab is pressed, the screen at right-hand side is shown:

- The left-hand top side is showing the directory where template files are located. The screenshot shows the default location for the template files. The program will remember the directory where the template was last loaded.
- The left-hand bottom side is showing the selected template.
- The right pane of the screenshot shows the tags with values that are send.



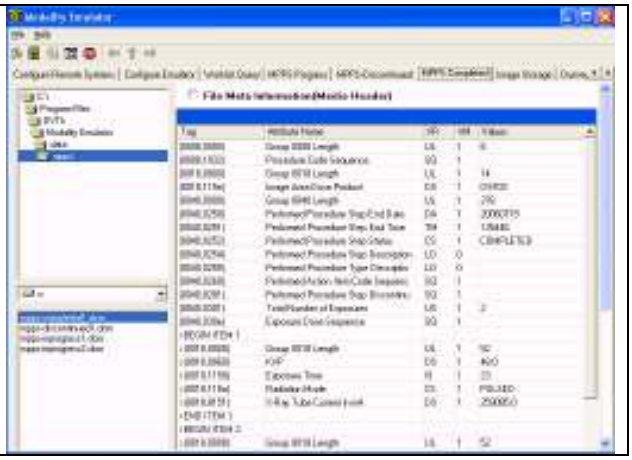
4.3.3 MPPS – Discontinued template

When the MPPS Discontinued tab is pressed, the screen at right-hand side is shown:



4.3.4 MPPS – Completed template

When the MPPS Completed tab is pressed, the screen at right-hand side is shown:



4.3.5 Image Storage

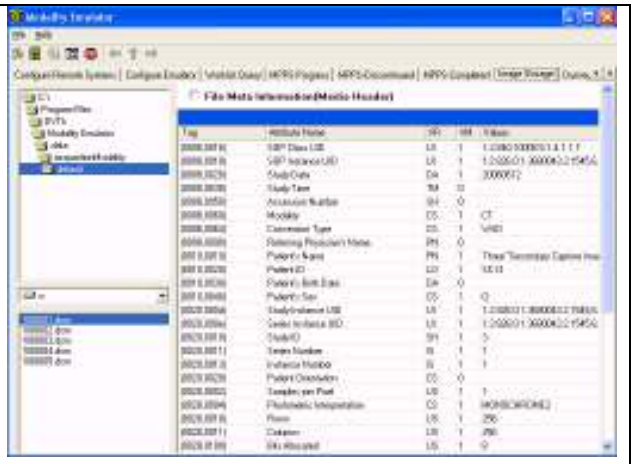
When the Image Storage tab is pressed, the screen at right-hand side is shown:

- The left-hand top-side is showing the directory where image files are located.
- All images in that directory will be send. (see example screenshot below).

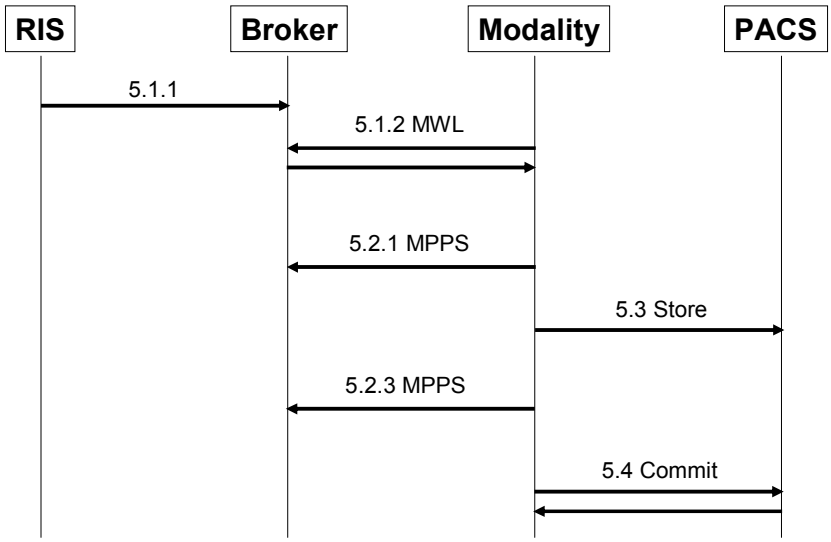
DVT Detailed Results File

Communication Overview:

Association Request
Association Accept
C-STORE-RQ Secondary Capture Image
C-STORE-RSP
C-STORE-RQ Secondary Capture Image
C-STORE-RSP
C-STORE-RQ Secondary Capture Image
C-STORE-RSP
C-STORE-RQ Secondary Capture Image
C-STORE-RSP
C-STORE-RQ Secondary Capture Image
C-STORE-RSP



5 Perform DICOM actions



5.1 MWL - Worklist Query

5.1.1 Make a booking on the RIS first!

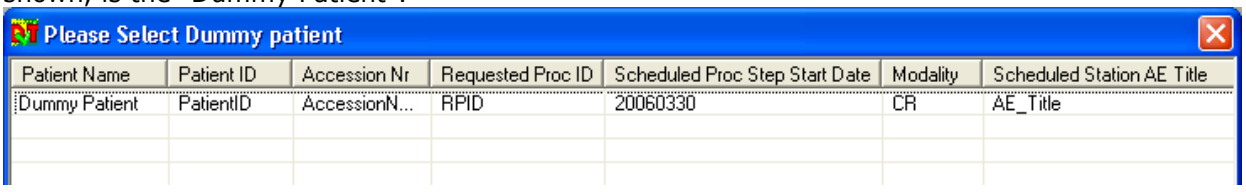
Before a Worklist query can be done, make sure that a patient is scheduled. The Booking must be done for the AET that has been done in step "Configure Emulator".

5.1.2 Perform the MWL query

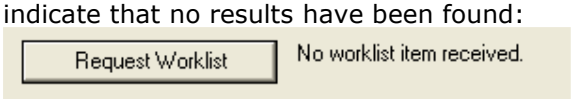
Press the button "Request Worklist".

No Patients Found

When no patients are found, or the query failed, the screen below will be shown. The only patient shown, is the "Dummy Patient".

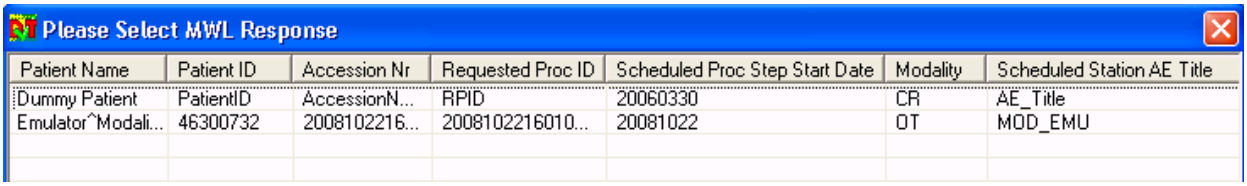


Select the "Dummy Patient" to continue. The text next to the Request Worklist button will indicate that no results have been found:

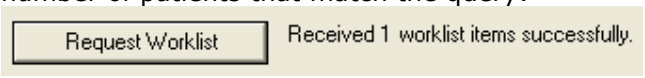


Patients Found

When the query results in one or more founds, the found names are listed, including the dummy patient.



Select a patient to continue. The text next to the Request Worklist button will indicate the number of patients that match the query:

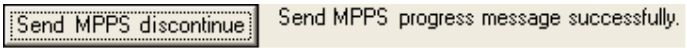


5.2 MPPS – Modality Performed Procedure Step

5.2.1 Progress

Press the button:

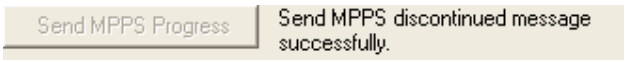
When the message has been send successfully, a return message is displayed:



5.2.2 Discontinued

Press the button:

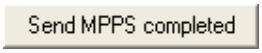
When the message has been send successfully, a return message is displayed:



5.2.3 Completed

The button completed does not exist yet. You first need to send an image.
See next paragraph **DICOM Store** for the steps to store an image.

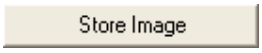
Press the button:



When the message has been send successfully, a return message is displayed:

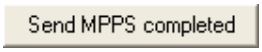
5.3 DICOM Store

Press the button:



When the image has been send successfully, a return message is displayed:

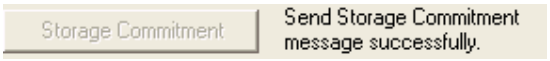
Now the button MPPS completed button becomes available:



5.4 Storage Commit

Press the button:

When Storage Commitment has been successful, a return message is displayed:



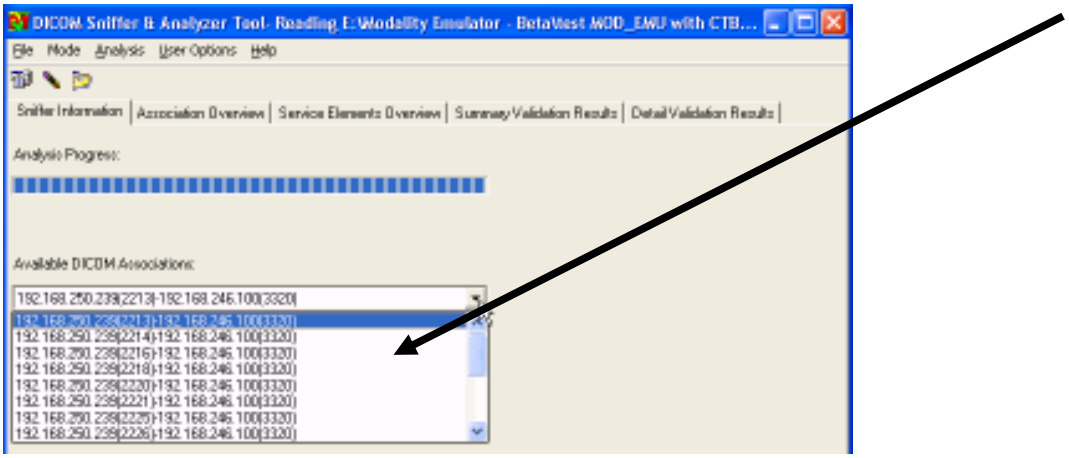
6 Special usage

6.1 Extract the templates from a capture

Maybe the most powerful usage of the Modality Emulator is the ability to load parts of a capture file that you have made to analyze the behaviour of a specific modality.

6.1.1 DICOM Network Analyzer

The first step is to make a capture using DICOM Network Analyzer.
Change from Capture to analysis mode. Depending on what you have captured one or more streams must be visible:

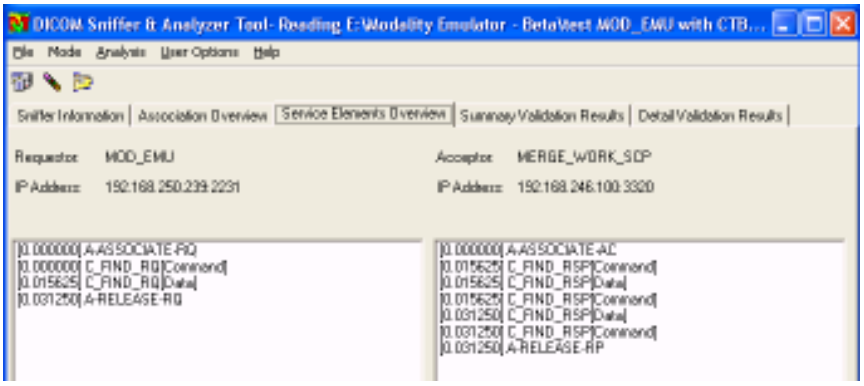


The paragraphs below describe how to extract the Worklist Query part and the MPPS messages.

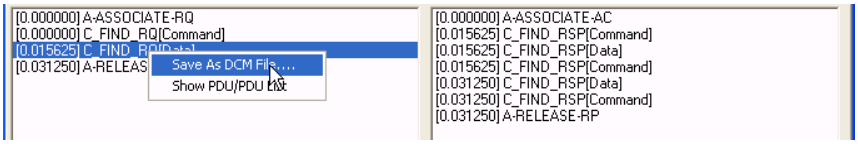
6.1.2 MWL template

Assuming that a capture has been made, is loaded in DICOM Network Analyzer and you are looking at the program in analysis mode.

To be able to extract a MWL-template from the capture, it must be there! Search in the available DICOM Associations for the stream that contains "C_FIND_RQ" (below an example).



Right-click on the "C_FIND_RQ[Data]" and select "Save As File":



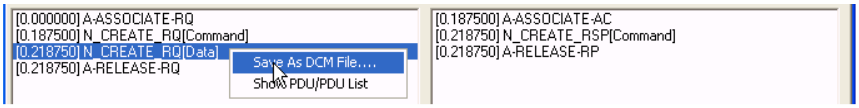
Navigate to a logical place and use a name that makes sense (e.g. US_HD11_**WLM**.dcm).

6.1.3 MPPS – N-Create

Repeat the steps as described for MWL.

To be able to extract a MPPS-template from the capture, it must be there! Search in the available DICOM Associations for the stream that contains "**N_CREATE_RQ**".

Right-click on the "N_CREATE_RQ[Data]" and select "Save As DCM File":

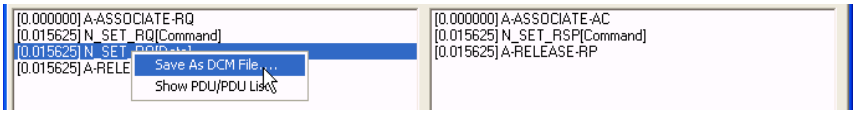


Navigate to a logical place and use a name that makes sense (e.g. US_HD11_**MPPS_C**.dcm).

6.1.4 MPPS – N-Get

Repeat the steps as described for MWL.

To be able to extract a MPPS-template from the capture, it must be there! Search in the available DICOM Associations for the stream that contains "**N_SET_RQ**" (below an example).

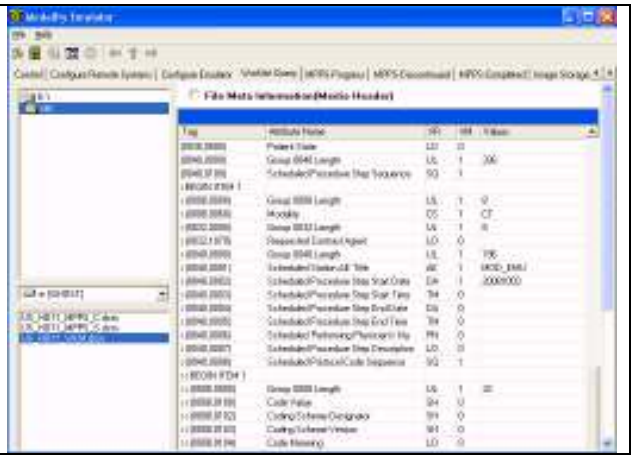


Navigate to a logical place and use a name that makes sense (e.g. US_HD11_**MPPS_S**.dcm).

6.2 Load the templates in the Emulator

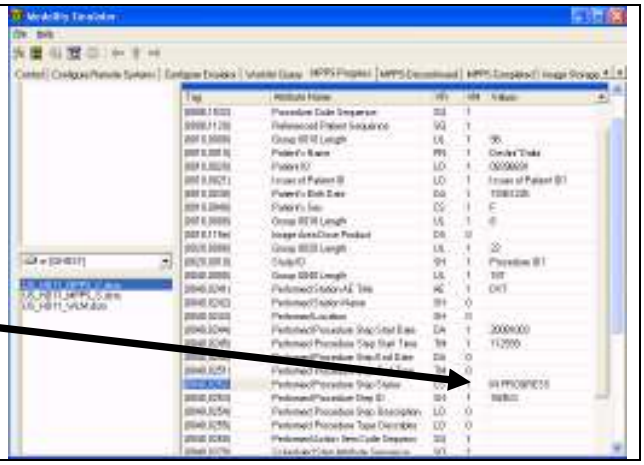
6.2.1 Load MWL template

- Select the Worklist Query tab,
- Navigate to the location where the MWL template has been stored.
- Click the file.



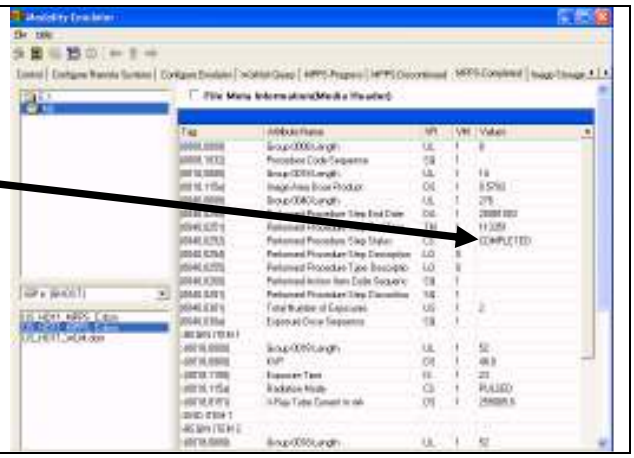
6.2.2 Load MPPS-Progress template

- Select the MPPS Progress tab,
- Navigate to the location where the MPPS template has been stored.
- Click the file.



6.2.3 Load MPPS-Completed template

- Select the MPPS Completed tab,
- Navigate to the location where the MPPS template has been stored.
- Click the file.



7 Mapping information

In Paragraph "6.1 Extract the templates from a capture" you have learned how to extract templates from a capture file. Next step is loading this template as "behaviour" for the Emulator. Now you may wonder why you want to store MPPS information of Mr. X while having Mr. Y in the Modality Emulator application! The overview below shows the re-mapping of the tool:

C-FIND-RSP: This is the response after a Modality Worklist Query
C-STORE: In the Modality Emulator these items are taken over from the C-FIND-RSP.
N-CREATE-RQ: In the Modality Emulator these items are taken over from the C-FIND-RSP.

CFINDRSP(Modality_Worklist_Information_Model_FIND)

```
SPECIFIC_CHARACTER_SET, CS
ACCESSION_NUMBER, SH
SCHEDULED_PROCEDURE_STEP_SEQUENCE, MODALITY, CS
REFERENCED_STUDY_SEQUENCE, SQ
PATIENTS_NAME, PN
PATIENT_ID, LO
PATIENTS_BIRTH_DATE, DA
PATIENTS_SEX, CS
STUDY_INSTANCE_UID, UI
REQUESTED_PROCEDURE_ID, SH
SCHEDULED_PROCEDURE_STEP_SEQUENCE, SCHEDULED_PROCEDURE_STEP_ID, SH
REQUESTED_PROCEDURE_DESCRIPTION, LO
SCHEDULED_PROCEDURE_STEP_SEQUENCE, SCHEDULED_PROCEDURE_STEP_DESCRIPTION, LO
```

CSTORERQ

```
SPECIFIC_CHARACTER_SET, CS
ACCESSION_NUMBER, SH
MODALITY, CS
REFERENCED_STUDY_SEQUENCE, SQ
PATIENTS_NAME, PN
PATIENT_ID, LO
PATIENTS_BIRTH_DATE, DA
PATIENTS_SEX, CS
STUDY_INSTANCE_UID, UI
REQUEST_ATTRIBUTES_SEQUENCE, REQUESTED_PROCEDURE_ID, SH
REQUEST_ATTRIBUTES_SEQUENCE, SCHEDULED_PROCEDURE_STEP_ID, SH
REQUEST_ATTRIBUTES_SEQUENCE, SCHEDULED_PROCEDURE_STEP_DESCRIPTION, LO
PERFORMED_PROCEDURE_STEP_ID, SH
PERFORMED_PROCEDURE_STEP_DESCRIPTION, LO
```

NCREATERQ(Modality_Performed_Procedure_Step)

```
SPECIFIC_CHARACTER_SET, CS
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, ACCESSION_NUMBER, SH
MODALITY, CS
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, REFERENCED_STUDY_SEQUENCE, SQ
PATIENTS_NAME, PN
PATIENT_ID, LO
PATIENTS_BIRTH_DATE, DA
PATIENTS_SEX, CS
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, STUDY_INSTANCE_UID, UI
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, REQUESTED_PROCEDURE_ID, SH
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, SCHEDULED_PROCEDURE_STEP_ID, SH
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, REQUESTED_PROCEDURE_DESCRIPTION, LO
SCHEDULED_STEP_ATTRIBUTES_SEQUENCE, SCHEDULED_PROCEDURE_STEP_DESCRIPTION, LO
PERFORMED_PROCEDURE_STEP_ID, SH
PERFORMED_PROCEDURE_STEP_DESCRIPTION, LO
```

DICOM attribute			Filling values for		
TAG	DICOM Item	VR	MWL retrieved	Store	MPPS
0008,0005	SPECIFIC CHARACTER SET	CS	Source	Copy	Copy
0008,0050	ACCESSION NUMBER	SH	Source	Copy	Copy
0008,1110	REFERENCED STUDY SEQUENCE	SQ	Source	Copy	-
0010,0010	PATIENTS NAME	PN	Source	Copy	Copy
0010,0020	PATIENT ID	LO	Source	Copy	Copy
0010,0030	PATIENTS BIRTH DATE	DA	Source	Copy	Copy
0010,0040	PATIENTS SEX	CS	Source	Copy	Copy
0020,000D	STUDY INSTANCE UID	UI	Source	Copy	
0032,1060	REQUESTED PROCEDURE DESCRIPTION	LO	Source		
0040,0253	PERFORMED PROCEDURE STEP ID	SH		Copy	Source
0040,0254	PERFORMED PROCEDURE STEP DESCRIPTION	LO		Copy	Source
0040,0270 -> 0008,0050	SCHEDULED STEP ATTRIBUTES SEQUENCE ACCESSION NUMBER	SQ SH	Source		Copy from source 0008,0050
0040,0270 -> 0008,1110	SCHEDULED STEP ATTRIBUTES SEQUENCE REFERENCED STUDY SEQUENCE	SQ SQ	Source		Copy from source 0008,1110
0040,0270 -> 0020,000D	SCHEDULED STEP ATTRIBUTES SEQUENCE STUDY INSTANCE UID	SQ UI	Source		Copy from source 0020,000D
0040,0270 -> 0040,1001	SCHEDULED STEP ATTRIBUTES SEQUENCE REQUESTED PROCEDURE ID	SQ SH	Source		Copy from source 0040,1001
0040,0270 -> 0040,0009	SCHEDULED STEP ATTRIBUTES SEQUENCE SCHEDULED PROCEDURE STEP ID	SQ SH	Source	-	Copy from source 0040,0009
0040,0270 -> 0032,1060	SCHEDULED STEP ATTRIBUTES SEQUENCE REQUESTED PROCEDURE DESCRIPTION	SQ LO	Source		Copy from source 0032,1060
0040,0270 -> 0040,0007	SCHEDULED STEP ATTRIBUTES SEQUENCE SCHEDULED PROCEDURE STEP DESCRIPTION	SQ LO	Source		Copy from source 0040,0007
0040,0275 -> 0040,1001	REQUEST ATTRIBUTES SEQUENCE REQUESTED PROCEDURE ID	SQ SH	Source	Copy from source 0040,1001	
0040,0275 -> 0040,0009	REQUEST ATTRIBUTES SEQUENCE SCHEDULED PROCEDURE STEP ID	SQ SH	Source	Copy from source 0040,0009	
0040,0275 -> 0040,0007	REQUEST ATTRIBUTES SEQUENCE SCHEDULED PROCEDURE STEP DESCRIPTION	SQ LO	Source	Copy from source 0040,0007	
0040,1000 -> 0008,0060	SCHEDULED PROCEDURE STEP SEQUENCE MODALITY MODALITY	SQ CS	Source	Copy	Copy
0040,1000 -> 0040,0009	SCHEDULED PROCEDURE STEP SEQUENCE SCHEDULED PROCEDURE STEP ID	SQ SH	Source	Copy	Copy
0040,1000 -> 0040,0007	SCHEDULED PROCEDURE STEP SEQUENCE SCHEDULED PROCEDURE STEP DESCRIPTION	SQ LO	Source	Copy	Copy
0040,1001	REQUESTED PROCEDURE ID	SH	Source		